STK502

User Guide

Table of Contents

Section 1

Introduction 1-1

Section 2

Using the STK502 Top Module 2-1

2.1 Connecting the STK502 to the STK500 Starter Kit 2-1

2.1.1 Placing an ATmega169 on STK502 2-1

2.2 PORT Connectors 2-2

2.2.1 PORT E/PORT F 2-2

2.2.2 PORT G/RST 2-2

2.3 Programming the ATmega169 2-4

2.3.1 In-System Programming 2-4

2.3.2 High-voltage Programming 2-5

2.4 JTAG Connector 2-6

2.5 LCD Display 2-7

2.5.1 Connecting the STK502 LCD to the ATmega169 2-7

2.5.2 Default Segment Configuration 2-7

2.5.3 Using Both Colons on the Display 2-8

2.6 TOSC Switch 2-10

2.7 Sensor 2-11

2.7.1 Sensor Switches 2-11

Section 3

Troubleshooting Guide 3-1

Section 4

Technical Specifications 4-1

4.1 STK502 LCD Bit Mappings 4-3

4.1.1 Alphanumeric Digit Number Two 4-3

4.1.2 Alphanumeric Digit Number Three 4-3

4.1.3 Alphanumeric Digit Number Four 4-3

4.1.4 Alphanumeric Digit Number Five 4-3

4.1.5 Alphanumeric Digit Number Six 4-4

4.1.6 Alphanumeric Digit Number Seven 4-4

Section 5

Technical Support 5-1

Section 6

Complete Schematics 6-1

Section 1

Introduction

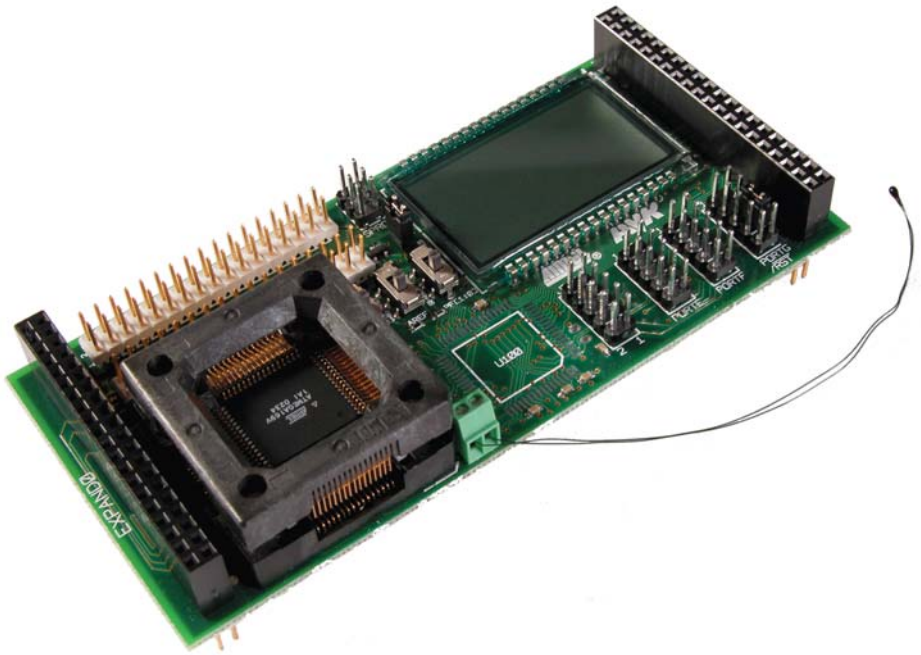
The STK502 board is a top module designed to add ATmega169 support to the STK500 development board from Atmel Corporation.

STK502 includes connectors and hardware allowing full utilization of the new features of the ATmega169. The Zero Insertion Force (ZIF) socket makes it easy to use of TQFP packages for prototyping.

This user guide is a general getting started guide as well as a complete technical reference for advanced users.

The STK502 board also includes a demonstration application, and comes with two application notes, “AVR064: STK502 – A Temperature Monitoring System with LCD Output” and “AVR065: LCD Driver for the STK502”. These application notes explain how to use the different modules in the device. Included in the kit is a pre-programmed ATmega169. Insert the device in the ZIF socket and the demonstration application will start immediately.

Figure 1-1. STK502 Top Module for STK500



1.1 Features

- Supports the ATmega169 with Built-in LCD Controller.
- LCD-on-glass Display for Demonstrating the ATmega169 LCD Controller.
- Supported by AVR Studio® 4.
- Zero Insertion Force Socket for TQFP Packages.
- High Voltage Parallel Programming.
- Serial Programming.
- TQFP Footprint for Emulator Adapters.
- Port Extension Connectors for Port E, F, and G.
- LCD Display Header for Using an External LCD Display.
- LCD and Other Peripherals Can be Disconnected from the Device.
- JTAG Connector for On-chip Debugging Using JTAG ICE.
- On-board 32 kHz Crystal for Easy Real Time Clock Implementations.
- Temperature Sensor for the Demo Application.
- Quick Reference to all Switches and Jumpers in the Silk-Screen of the PCB.
- Pre-programmed ATmega169 with Demonstration Application. Includes C-code Examples for all Major Peripherals on the ATmega169 Device.
  - The Way to Get Going with your ATmega169

Section 2

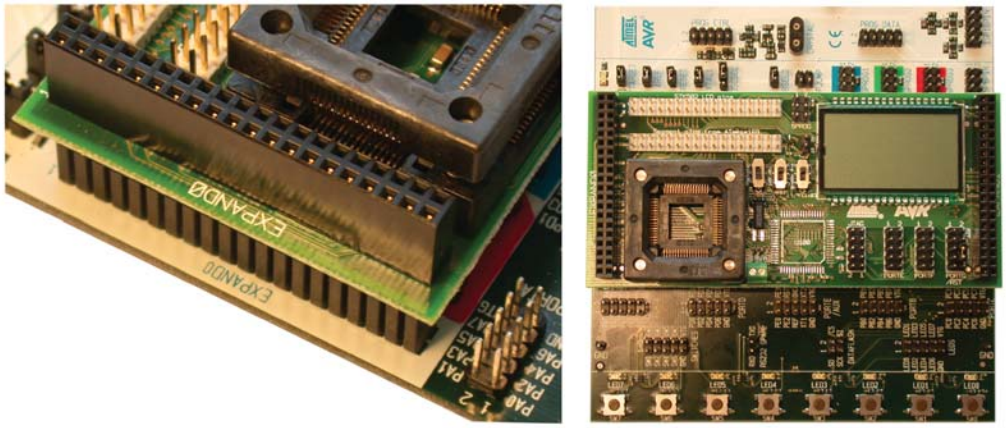
Using the STK502 Top Module

This section describes in detail how the STK502 is used with the STK500.

2.1 Connecting the STK502 to the STK500 Starter Kit

Connect STK502 to the STK500 expansion header 0 and 1. It is important that the top module is connected in the correct orientation as shown in Figure 2-1. EXPAND0 written on the STK502 top module should match EXPAND0 written beside the expansion header on the STK500 board.

Figure 2-1. Connecting STK502 to the STK500 Board

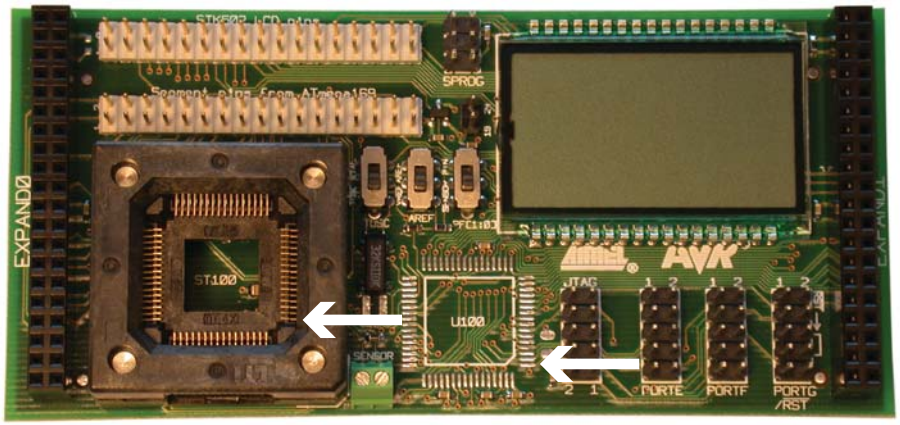


Note: Connecting STK502 with wrong orientation may damage the board.

2.1.1 Placing an ATmega169 on STK502

STK502 contains both a ZIF socket, and a footprint for a TQFP package which allows an easy way of soldering an emulator adapter directly into the STK502. Care should be taken so that the device (or adapter) is mounted with the correct orientation. Figure 2-2 shows the location of pin1 for the ZIF socket and the TQFP footprint.

Figure 2-2. Pin1 on ZIF Socket and TQFP Footprint



Caution: Do not mount an ATmega169 on the STK502 at the same time as an AVR is mounted on the STK500 board. Neither of the devices will work as intended.

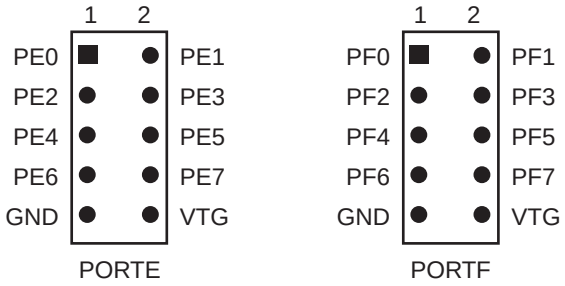
2.2 PORT Connectors

ATmega169 have additional ports to those available on the STK500. The ports are located on the STK502 board. They have the same pin out and functionality as the ports on the STK500 board. Port A to Port D are already present on the STK500 board. They are not duplicated on the STK502.

2.2.1 PORT E/PORT F

Figure 2-3 shows the pin out for the I/O port headers Port E and Port F.

Figure 2-3. General I/O Ports

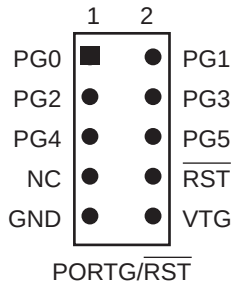


Note: Port E is also present on the STK500, but only PE0 to PE2 (three least significant bits) are accessible there. To access all Port E bits the connector on the STK502 must be used.

2.2.2 PORT G/$\overline{\text{RST}}$

In addition to the normal Port G pins, this connector has the $\overline{\text{RESET}}$-signal. Se Figure 2-4.

Figure 2-4. PORTG/$\overline{\text{RST}}$



2.2.2.1 PG0 - PG5

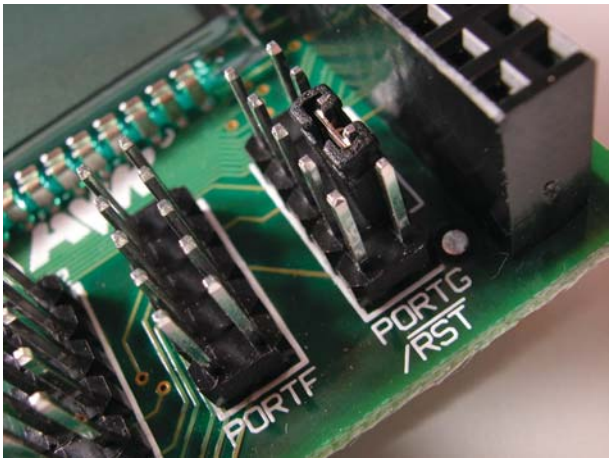
These are general I/O ports connected to ZIF socket and the TQFP footprint.

2.2.2.2 $\overline{\text{RST}}$

On the ATmega169 the $\overline{\text{RESET}}$-signal and PG5 share the same pin. The "$\overline{\text{RST}}$" is the RESET-signal that comes from the STK500 board. Please note that it is not directly connected to the ZIF socket or the TQFP footprint on the STK502. This because the RESET-signal on the STK500 has an pull-up resistor to VCCT which will interfere with PG5 when used as an ordinary I/O-pin.

- If $\overline{\text{RESET}}$/PG5-pin on ATmega169 shall be used as a Reset pin, the $\overline{\text{RST}}$ and PG5 on the PORTG /RST must be connected with a jumper. See Figure 2-5.
- If the pin shall be used as an I/O-pin the jumper must be removed.

Figure 2-5. The $\overline{\text{RESET}}$ Signal on PORTG/$\overline{\text{RST}}$



2.3 Programming the ATmega169

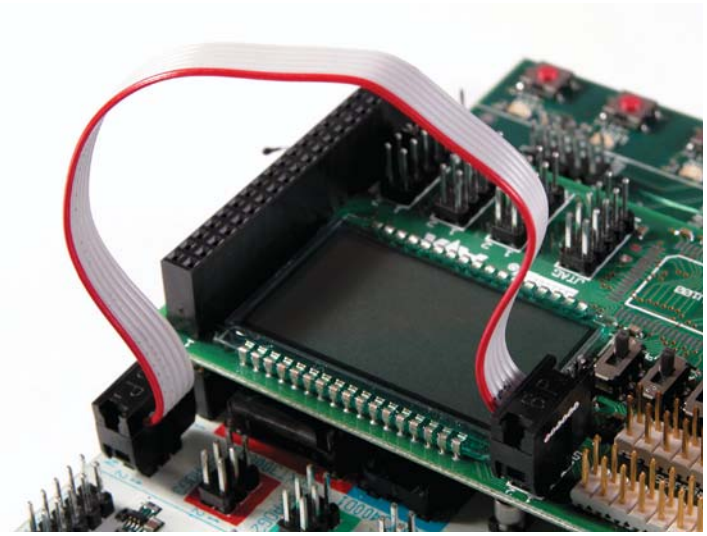
The ATmega169 can be programmed using both SPI and High-voltage Parallel Programming. This section will explain how to connect the programming cables to successfully use one of these two modes. The AVR Studio STK500 software is used in the same way as for other AVR parts as described in the STK500 User Guide.

Note: The ATmega169 also support Self Programming, See AVR109 application note for more information on this topic.

Note: The jumper for the Reset-signal on PORTG/$\overline{\text{RST}}$ must be mounted before any programming can take place. See Section 2.2.2.2

2.3.1 In-System Programming

Figure 2-6. In-System Programming

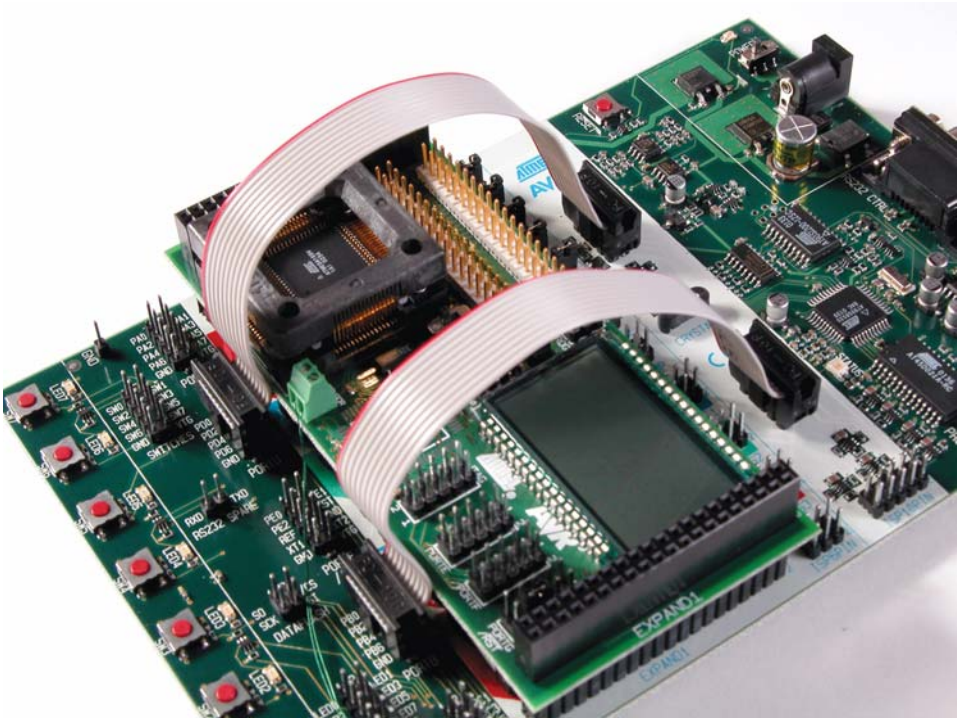


To program the ATmega169 using ISP Programming mode, connect the 6-wire cable between the ISP6PIN connector on the STK500 board and the ISP connector on the STK502 board as shown in Figure 2-6. The device can be programmed using the Serial Programming mode in the AVR Studio4 STK500 software.

Note: See STK500 User Guide for information on how to use the STK500 front-end software for ISP Programming.

2.3.2 High-voltage Programming

Figure 2-7. High-voltage (Parallel) Programming



To program the ATmega169 using High-voltage (Parallel) Programming, connect the PROGCTRL to PORTD and PROGDATA to PORTB on the STK500 as shown in Figure 2-7. Make sure that the TOSC-switch is placed in the XTAL position. See Section 2.6, “TOSC Switch”.

As described in the STK500 User Guide (jumper settings), mount the BSEL2 jumper in order to High-voltage Program the ATmega devices. This setting also applies to High-voltage Programming of the ATmega169.

The device can now be programmed using the High-voltage Programming mode in AVR Studio STK500 software.

Note: See the STK500 User Guide for information on how to use the STK500 front-end software in High-voltage Programming mode.

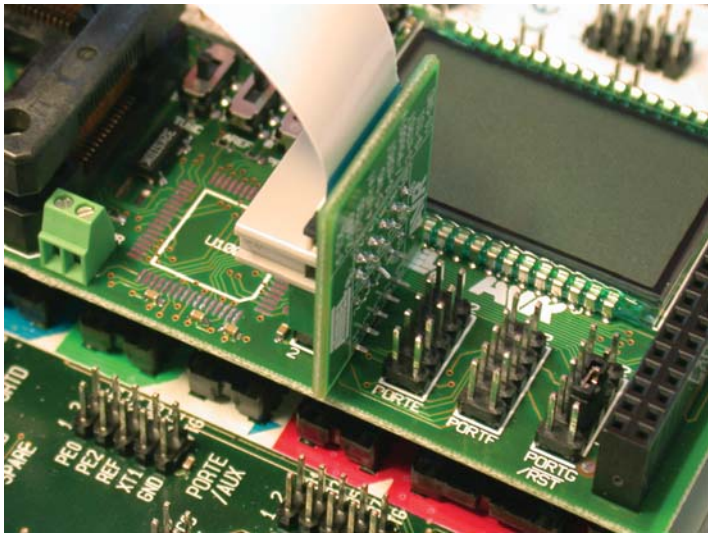
Note: For the High-voltage Programming mode to function correctly, the target voltage must be higher than 4.5V.

Caution: Make sure to disconnect LCD-display from the segment pins header. Otherwise the lifetime of the LCD display may be severely reduced. See Figure 2-10.

2.4 JTAG Connector

Figure 2-8 shows how to connect the JTAG ICE probe on the STK502 board.

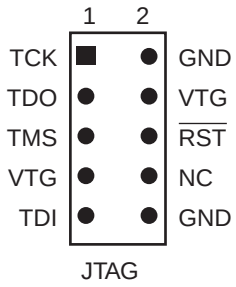
Figure 2-8. Connecting JTAG ICE to the STK502



The JTAG connector is used for the ATmega169 built-in JTAG interface. The pin out of the connector is shown in Figure 2-9 and is compliant with the pin out of the JTAG ICE available from Atmel. Connecting a JTAG ICE to this connector allows On-chip Debugging of the ATmega169.

More information about the JTAG ICE and On-chip Debugging can be found in the AVR JTAG ICE User Guide, which is available at the Atmel web site, www.atmel.com.

Figure 2-9. JTAG Connector



2.5 LCD Display

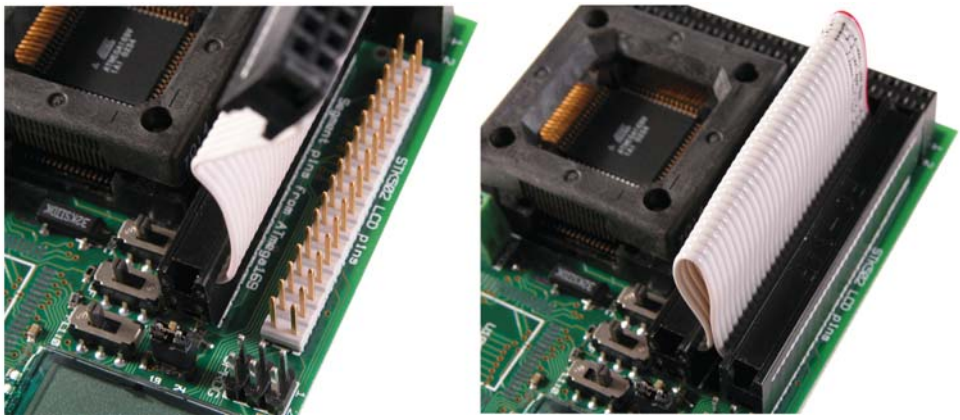
STK502 includes a LCD display. It features six 14-segments digits, and some additional segments. All in all the display supports 120 segments. The display is designed for 3V operating voltage. See the Technical Specifications for more details on the display.

2.5.1 Connecting the STK502 LCD to the ATmega169

The segment-pins from the ATmega169 are located at PORTA, PORTC, PORTD, and PORTG. For simplicity in use they are all joined together on the header labeled "Segment pins from ATmega169". The header next to it, labelled "STK502 LCD pins" holds all the segments-pins for the LCD-display on the STK502.

By using the 34-lead cable that comes with the STK502-kit, the two pin-headers can be connected, allowing the ATmega169 to control the LCD-display. See Figure 2-10.

Figure 2-10. Connecting the ATmega169 to the STK502 LCD



Caution: High-voltage Programming uses PORTB and PORTD. Be sure to disconnect any LCD-display connected to the ATmega169 during the High-voltage Programming. Otherwise the lifetime of the display may be reduced.

Caution: When using PORTA, PORTC, PORTD, or PORTG as regular I/O ports, the corresponding LCD-segment pins must be disconnected from the ATmega169.

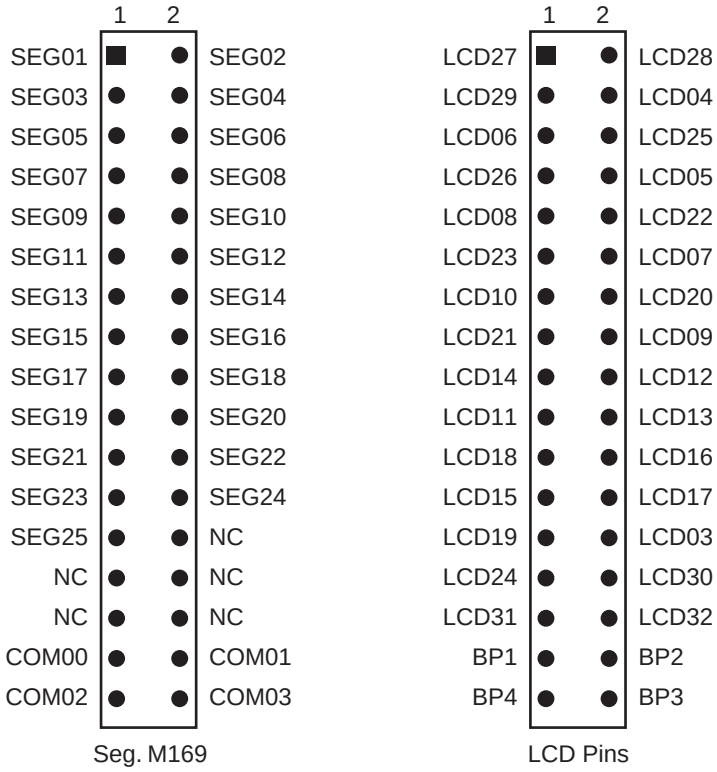
2.5.2 Default Segment Configuration

ATmega169 supports 100 segments. Thus not all of the 120 segments on the LCD-display can be shown simultaneously. Five of the 30 segment-pins on the LCD display has to be left unconnected. The LCD-pins that are not connected are pin #: 3, 24, 30, 31, and 32. See Technical Specifications for an overview of the excluded segments.

In order to use some of the segments on the LCD display that by default are not included or in order to use some of the segment pins as ordinary I/O-pins, use a custom strap between the two 34-pin headers. These to headers are lined up so they will fit in to a 2.54 mm pitch grid for easy connecting, e.g., a experiment board on top of them.

The pin out for these two headers (Figure 2-11) can be found on the bottom-side of the STK502-PCB or in Section 6 "Complete Schematics".

Figure 2-11. Pin out for LCD Headers



This hardware configuration will give a certain bit-mapping between the bits in the ATmega169 LCDDRx Register and the segments on the STK502 LCD. See Section 4.1 “STK502 LCD Bit Mappings”

2.5.3 Using Both Colons on the Display

With the header J300 labelled “19 24” one can connect LCD-pin 24 (which is default unconnected) to LCD-pin 19 by the use of a jumper. See Figure 2-12. The reason for doing so is that the LCD-pin 24 has the segment “COL1” and LCD-pin 19 has “COL2”. In applications where a clock, date etc. shall be displayed, it can be useful to control both colons on the LCD-display. But connecting these LCD-pins will also lead to a connection between segment (see Technical Specifications) “S5” and “3”, “S8” and “S7”, “8” and “7”, which will in practice make them useless. See Figure 2-13 showing which segments are available on the LCD-display with the default segment configuration.

Figure 2-12. Jumper to connect COL1 to COL2

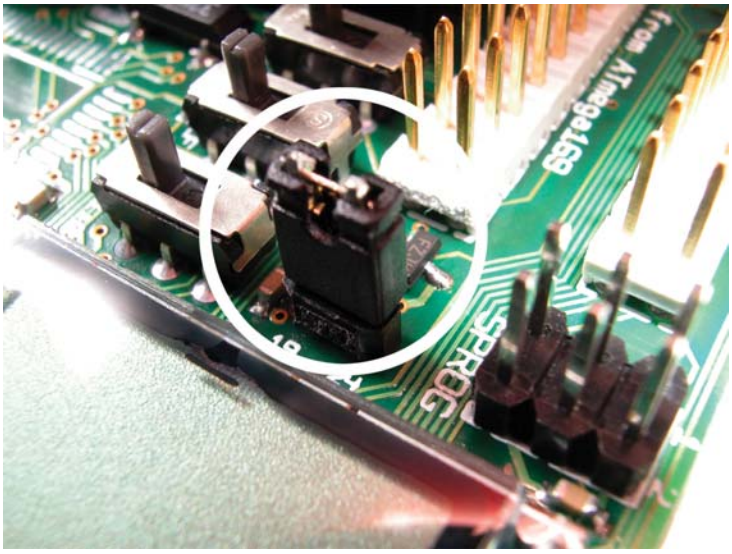
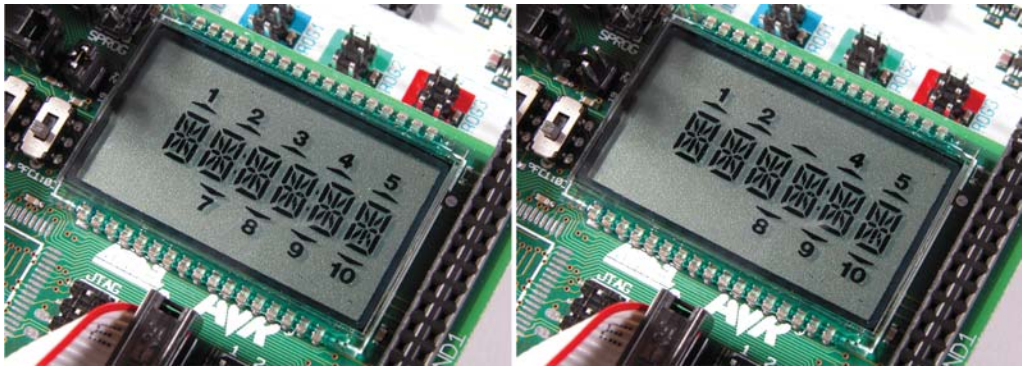


Figure 2-13. Default LCD-segment configuration, with and without the jumper shown in Figure 2-12



Other LCD-displays can be connected to the ATmega169, either through the header “Segment pins from ATmega169” where all the segment pins are gathered or through the ordinary Port-connectors PORTA, PORTC, PORTD, and PORTG.

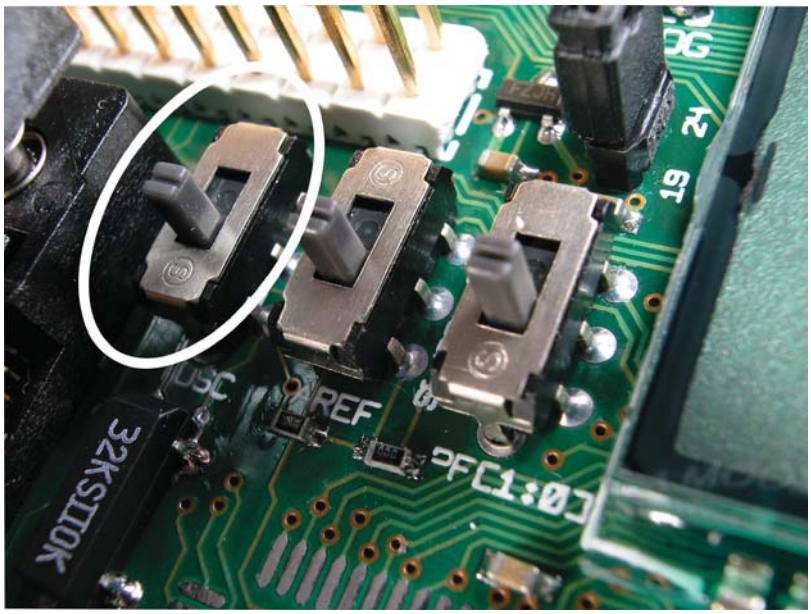
Note: Make sure the display is compatible with the electrical characteristics on the ATmega169.

For more information on how to write software for the LCD-display see application note “AVR064: STK502 – A Temperature Monitoring System with LCD Output” and application note “AVR065: LCD Driver for the STK502 LCD”.

Note: The LCD-display on the STK502 can be ordered separately from ACTE Norway (www.acte.no).
Phone: +47 63 89 89 00
Fax: +47 63 87 90 00
E-mail: info@acte.no
Price: NOK 99,-
Ordering number: H4042-DL DE5156/L.

2.6 TOSC Switch

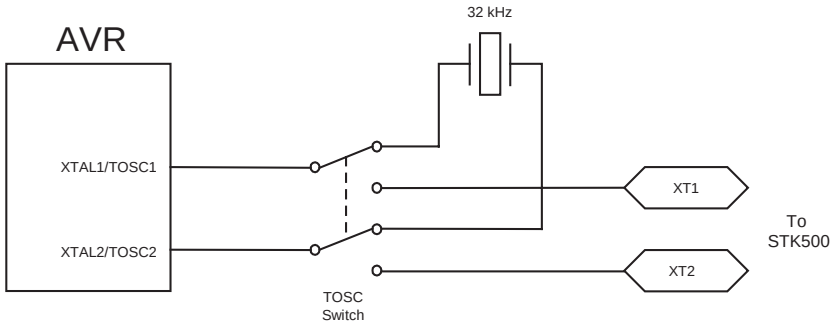
Figure 2-14. TOSC Switch



On the ATmega169 the TOSC1 and TOSC2 lines are shared with XTAL1 and XTAL2. The TOSC switch selects whether the 32 kHz crystal on the STK502, or the XT1/XT2 signals from STK500 should be connected to these pins on the device.

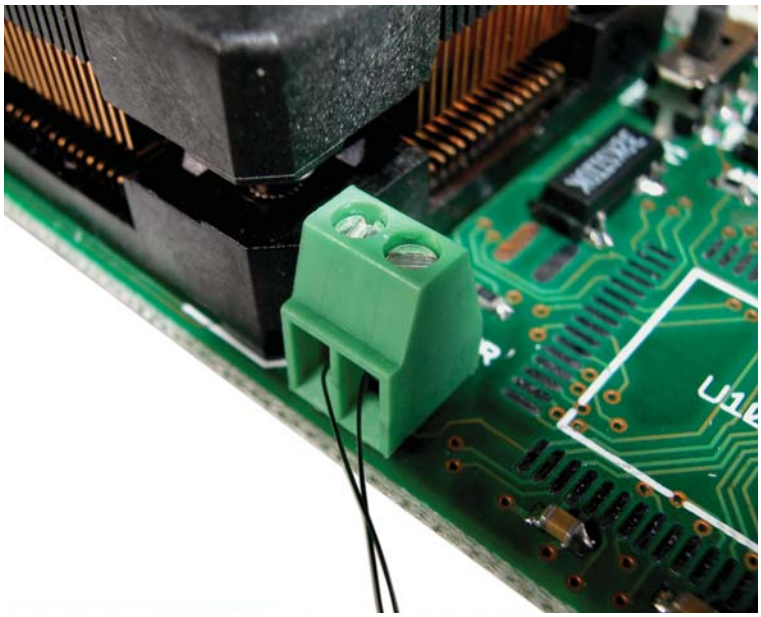
Figure 2-15 shows a simplified block schematic on how this is implemented.

Figure 2-15. TOSC Block Schematic



2.7 Sensor

Figure 2-16. NTC-thermistor

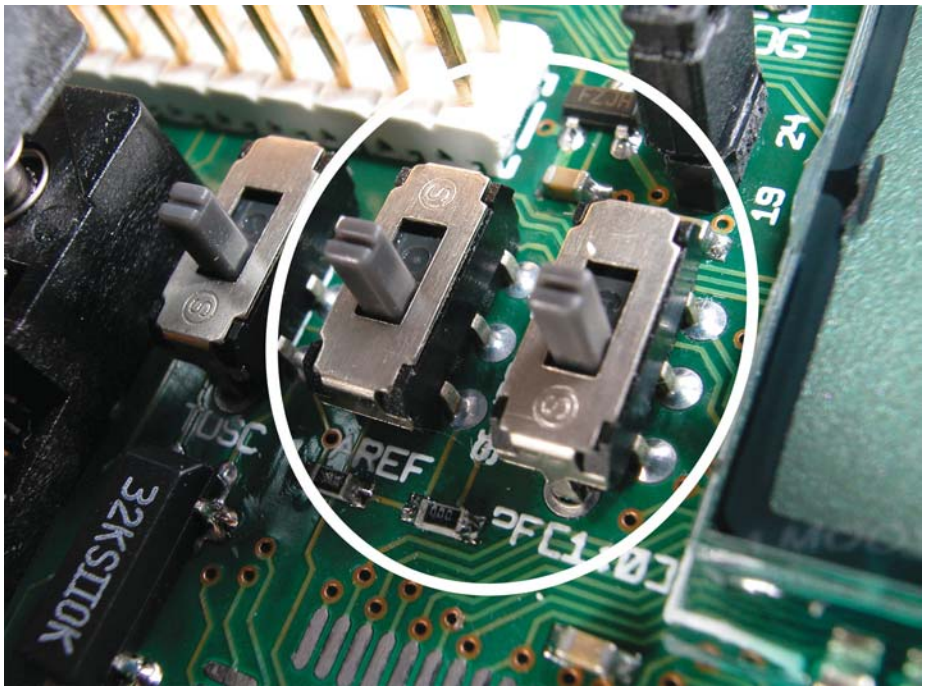


STK502 includes a two screw-terminal block where a sensor can be connected. The STK502 kit is shipped with a NTC-thermistor attached to this screw-terminal. A NTC-thermistor is characterised by the fact that when the temperature goes down the resistance goes up. Using a voltage divider and reading the voltage over the thermistor through the ADC-channels on ATmega169, the temperature can be calculated. Application note “AVR064: STK502 – A Temperature Monitoring System with LCD Output” describes the details of the application.

2.7.1 Sensor Switches

Two switches on the STK502 are used to connect the sensor to the ADC-channels on the ATmega169 as shown in Figure 2-17.

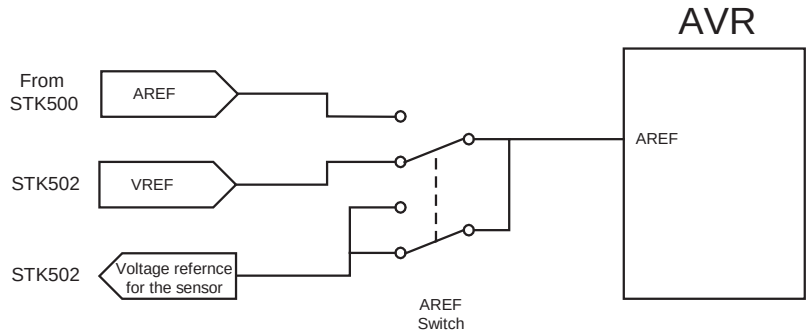
Figure 2-17. Temperature sensor switches



2.7.1.1 AREF Switch

The switch named AREF selects the input to the AREF-pin on the ATmega169.

Figure 2-18. AREF Switch



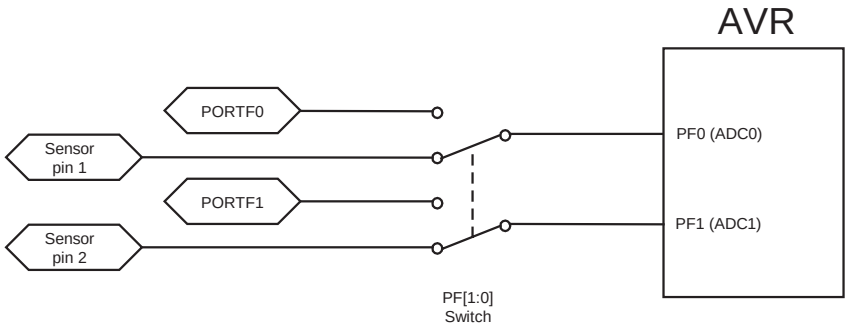
Positions:

- AREF: In this position the AREF from the STK500 is connected to the AREF pin on the ATmega169. This is the default position.
- VREF: In this position the VREF from the 1.263V voltage reference on the STK502 is connected to the AREF pin on the ATmega169. Select this position in order to run the code in Application Note “AVR064: STK502 – A Temperature Monitoring System with LCD Output”

2.7.1.2 PF[1:0] Switch

The PF[1:0] switch selects the input to the PF1 and PF0 pins (ADC channel 1/0) on the ATmega169.

Figure 2-19. PF[1:0] Switch



Positions:

- PIN: In this position the PF0 and PF1 are from the PORTF on the STK502 are connected to the PF0 and PF1 on the ATmega169. Default position.
- Sensor: In this position the pin 1 from the screw-terminal on the STK502 are connected to PF0 on the ATmega169, and the pin 2 from the screw-terminal are connected to PF1 on the ATmega169. Select this position in order to run the code in Application Note “AVR064: STK502 – A Temperature Monitoring System with LCD output”

In the sensor position both PF0 and PF1 are connected to the senor pins, regardless of using single ended or differential ADC-measurements in the application. This means that it's not possible to use PF1 as an ordinary I/O-port even though only PF0 (single ended) is used with the ADC.

Section 3

Troubleshooting Guide

Table 3-1. Troubleshooting Guide

Problem	Reason	Solution
Nothing is displayed on the LCD.	The LCD is not connected.	Attach the 34-pins cable between the to 34-pins headers on the STK502.
	The LCD is not enabled in the AVR device.	Check the LCD initialisation(1).
	The update frequency is not correct.	Verify that the clock prescaling correspond with the clock source(1).
Some segments on the LCD seems to be stuck at high/low.	The PORTA/C/D and/or G are connected to something else than the LCD display.	Check that nothing is connected to these PORTS on the STK500 and STK502.
Can't control PORTF[1:0]	PF[1:0] is not connected to the ATmega169.	Set the PF[1:0] switch in the PIN-position.
Serial Programming does not work	ISP cable not connected.	Connect the ISP cable according to Figure 2-6.
	STK500 target voltage error.	Please refer to the ATmega169 datasheet for the Serial Programming Voltage limits. Adjust the target voltage on the STK500 board accordingly.
	The RSTDISBL Fuse is programmed.	Use Parallel Programming to unprogram the RSTDISBL Fuse.

Table 3-1. Troubleshooting Guide

Problem	Reason	Solution
Parallel Programming does not work.	Cables not connected properly.	Please refer to Figure 2-7 for correct Parallel Programming setup.
	STK500 target voltage error.	Please refer to the ATmega169 data sheet for the Parallel Programming Voltage limits. Adjust the target voltage on the STK500 board accordingly.
	The TOSC switch is not correctly set.	Set the TOSC switch in the XTAL-position.
No programming works.	The $\overline{\text{RESET}}$-signal is not connected to the ATmega169.	Connect PG5 and $\overline{\text{RST}}$ with a jumper. See Section 2.2.2.2 RST.

Note: 1. See the application note “AVR065: LCD Driver for the STK502 LCD” on how to control the LCD-display or the the application note “AVR064: STK502 – A Temperature Monitoring System with LCD Output”.

Section 4v

Technical Specifications

System Unit

Physical Dimensions . . . . . 56 x 119 x 27 mm

Weight . . . . . 70 g

Operating Conditions

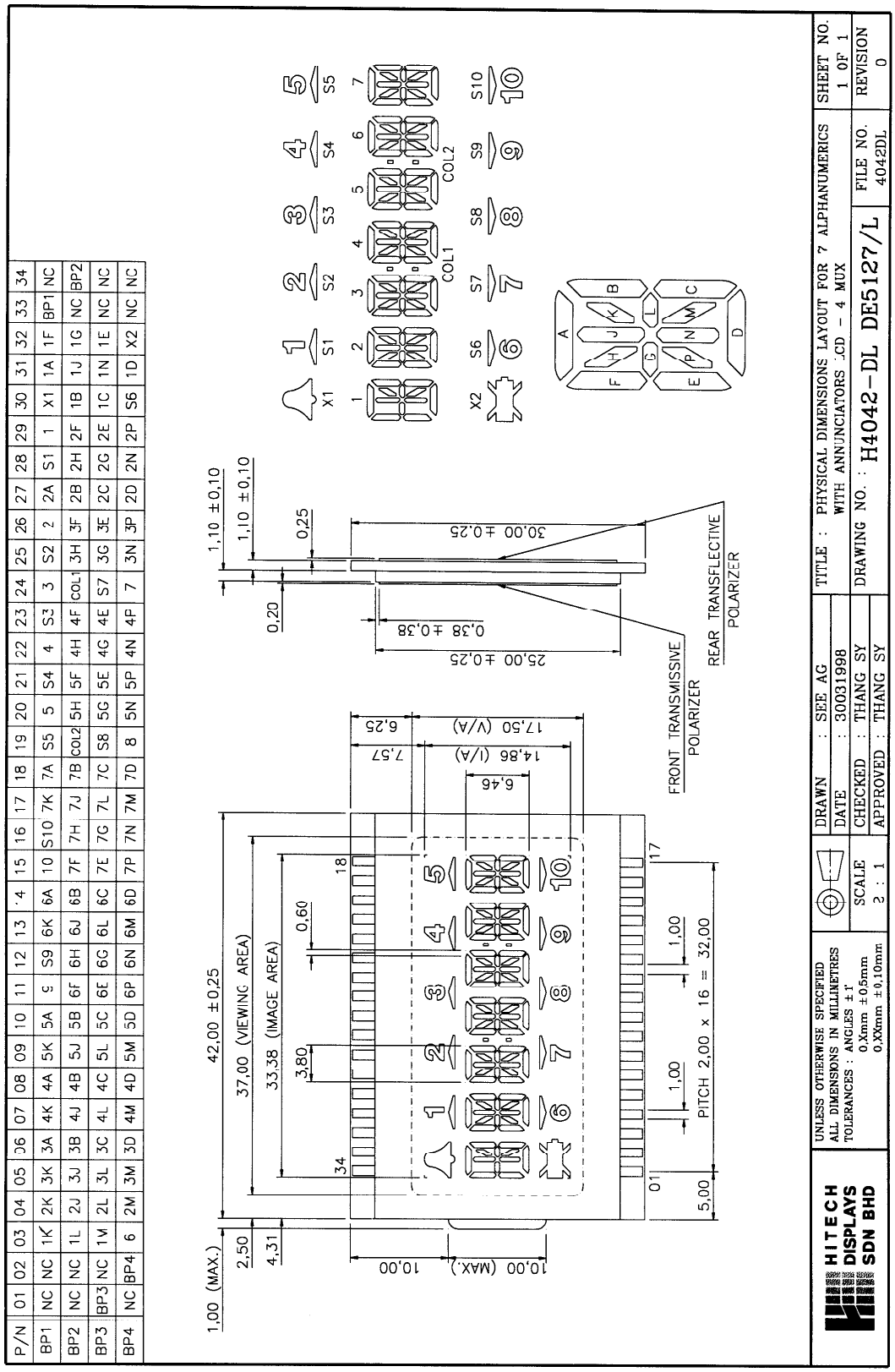
Voltage Supply . . . . . 1,8V - 5,5V

Temperature . . . . . 0°C - 50°C

LCD-display

Operation voltage 3V

Figure 4-1. Layout for the STK502 LCD-display



4.1 STK502 LCD Bit Mappings

The LCD Data Registers (LCDDRx) in the ATmega169 are organized in groups according to the use of Backplane Control Lines (also known as Common Lines). The LCD on the STK502 uses all four Common Lines and all 25 segments, in total 4 x 25 = 100 segments. As can be seen in the LCD data sheet (Figure 4-1) describing the internal connection of pins, Common Lines and segments, the alphanumeric digits are referred to with a number according to where they are located on the LCD. Listed below is a description of the STK502 bit mappings according to this.

4.1.1 Alphanumeric Digit Number Two

The bit mappings for the alphanumeric digit number two are listed below.

Table 4-1. Bit Mappings for LCD Alphanumeric Digit Number Two

Register Name	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
LCDDR0					2-K	1	S1	2-A
LCDDR5					2-J	2-F	2-H	2-B
LCDDR10					2-L	2-E	2-G	2-C
LCDDR15					2-M	2-P	2-N	2-D

4.1.2 Alphanumeric Digit Number Three

The bit mappings for the alphanumeric digit number three are listed below.

Table 4-2. Bit Mappings for LCD Alphanumeric Digit Number Three

Register Name	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
LCDDR0	3-K	2	S2	3-A				
LCDDR5	3-J	3-F	3-H	3-B				
LCDDR10	3-L	3-E	3-G	3-C				
LCDDR15	3-M	3-P	3-N	3-D				

4.1.3 Alphanumeric Digit Number Four

The bit mappings for the alphanumeric digit number four are listed below.

Table 4-3. Bit Mappings for LCD Alphanumeric Digit Number Four

Register Name	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
LCDDR1					4-K	S3	4	4-A
LCDDR6					4-J	4-F	4-H	4-B
LCDDR11					4-L	4-E	4-G	4-C
LCDDR16					4-M	4-P	4-N	4-D

4.1.4 Alphanumeric Digit Number Five

The bit mappings for the alphanumeric digit number five are listed below.

Table 4-4. Bit Mappings for LCD Alphanumeric Digit Numer Five

Register Name	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
LCDDR1	5-K	S4	5	5-A				
LCDDR6	5-J	5-F	5-H	5-B				
LCDDR11	5-L	5-E	5-G	5-C				
LCDDR16	5-M	5-P	5-N	5-D				

4.1.5 Alphanumeric Digit Number Six

The bit mappings for the alphanumeric digit number six are listed below.

Table 4-5. Bit Mappings for LCD Alphanumeric Digit Number Six

Register Name	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
LCDDR2					6-K	9	S9	6-A
LCDDR7					6-J	6-F	6-H	6-B
LCDDR12					6-L	6-E	6-G	6-C
LCDDR17					6-M	6-P	6-N	6-D

4.1.6 Alphanumeric Digit Number Seven

The bit mappings for the alphanumeric digit number seven are listed below.

Table 4-6. Bit Mappings for LCD Alphanumeric Digit Number Seven

Register Name	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
LCDDR2	7-K	10	S10	7-A				
LCDDR7	7-J	7-F	7-H	7-B				
LCDDR12	7-L	7-E	7-G	7-C				
LCDDR17	7-M	7-P	7-N	7-D				

Section 5

Technical Support

For Technical support, please contact avr@atmel.com. When requesting technical support, please include the following information:

- Which target AVR device is used (complete part number).
- Target voltage and speed.
- Clock source and fuse setting of the AVR.
- Programming method (ISP or High-voltage).
- Hardware revisions of the AVR tools, found on the PCB.
- Version number of AVR Studio. This can be found in the AVR Studio help menu.
- PC operating system and version/build.
- PC processor type and speed.
- A detailed description of the problem.

Section 6

Complete Schematics

On the following pages the complete schematics and assembly drawing of the STK502 revision B are shown.

Figure 6-1. Schematics, 1 of 3

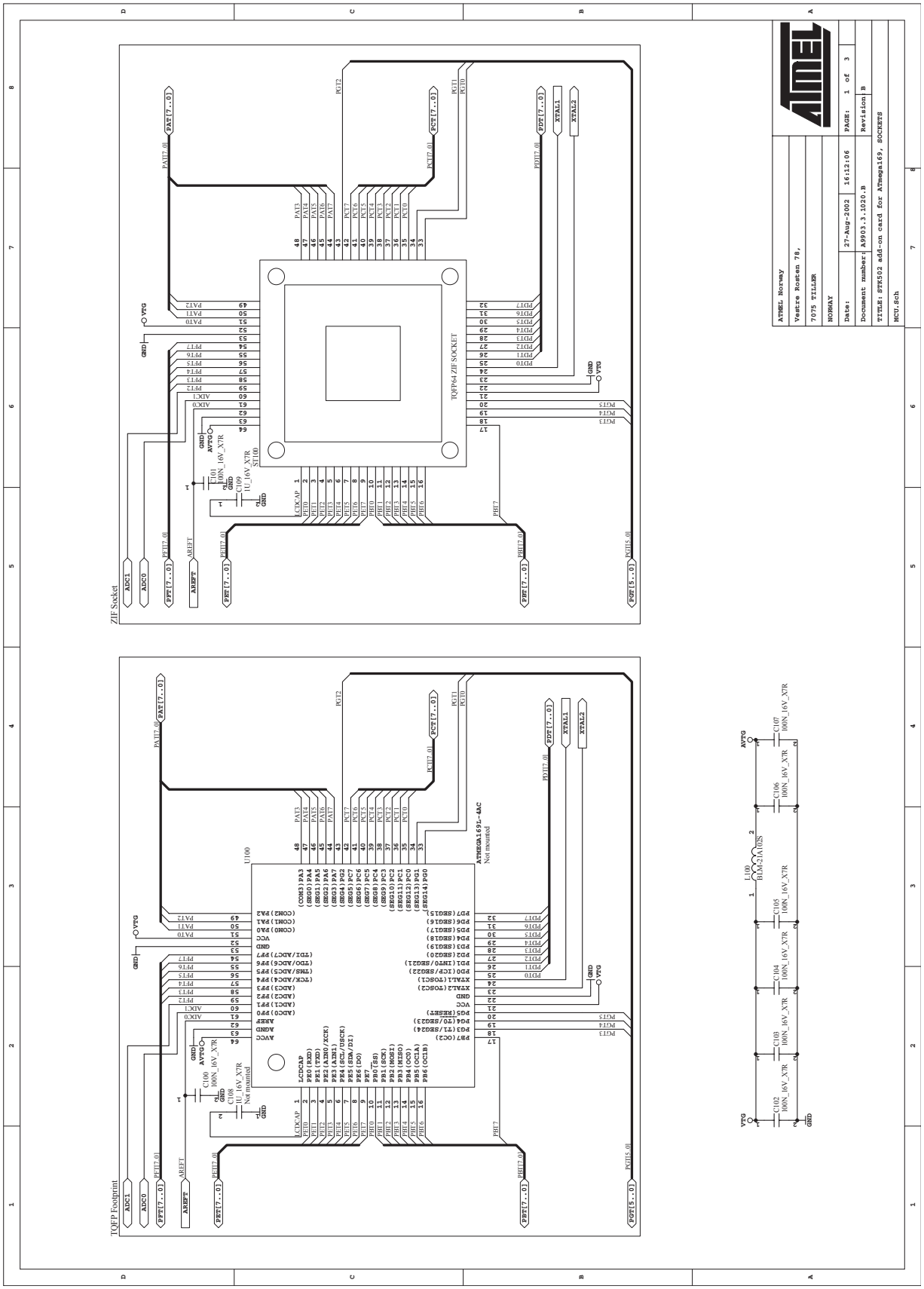


Figure 6-2. Schematics, 2 of 3

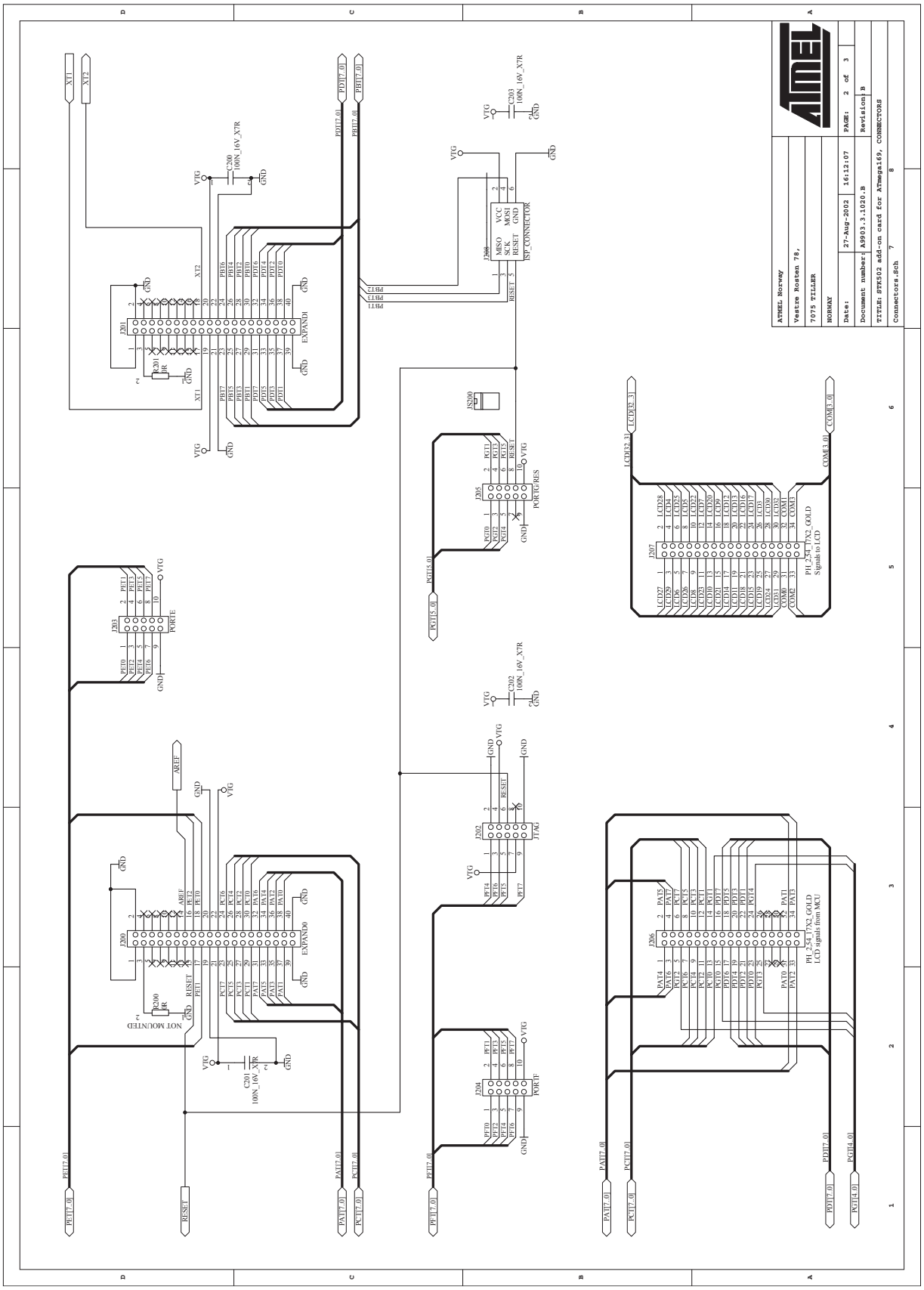


Figure 6-3. Schematics, 3 of 3

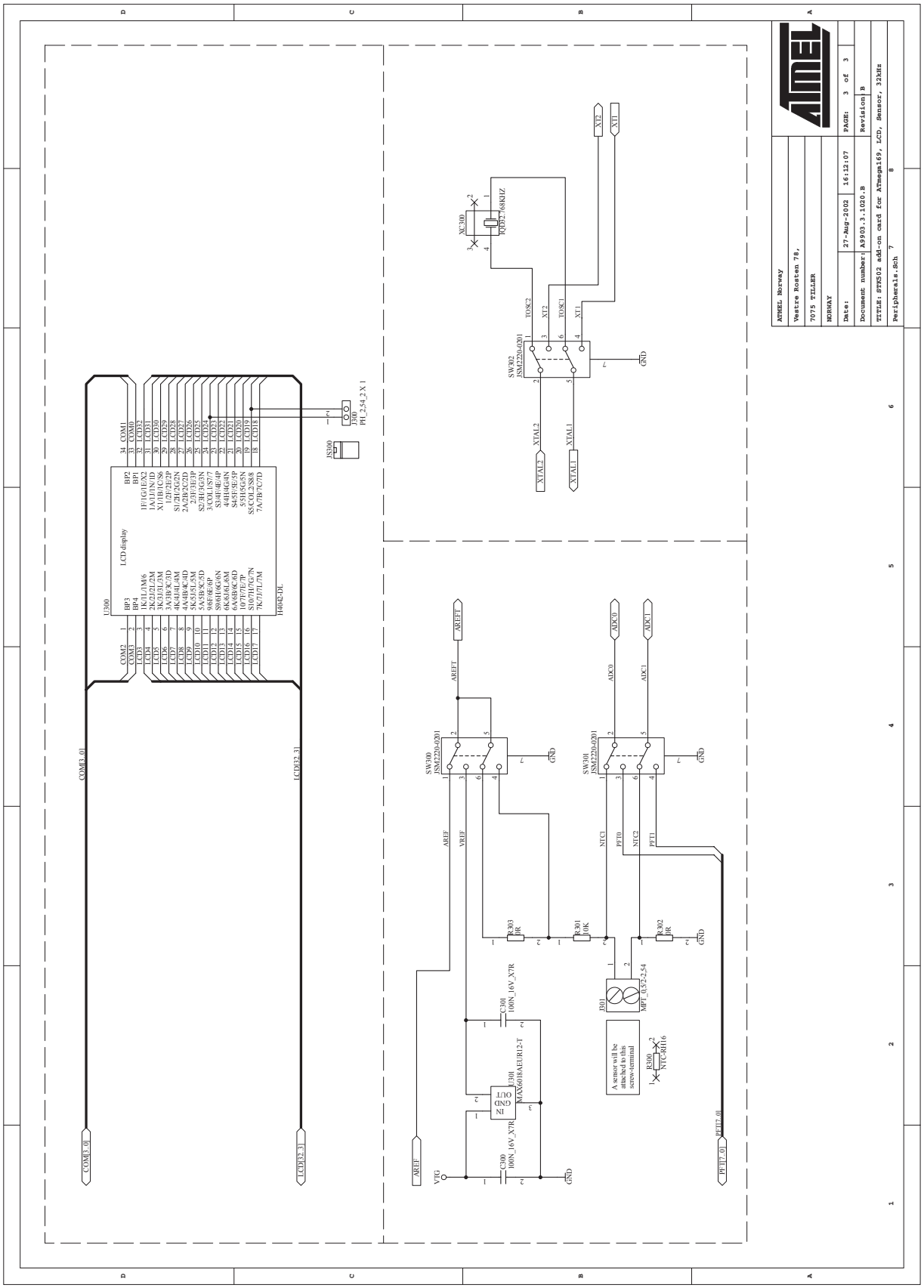
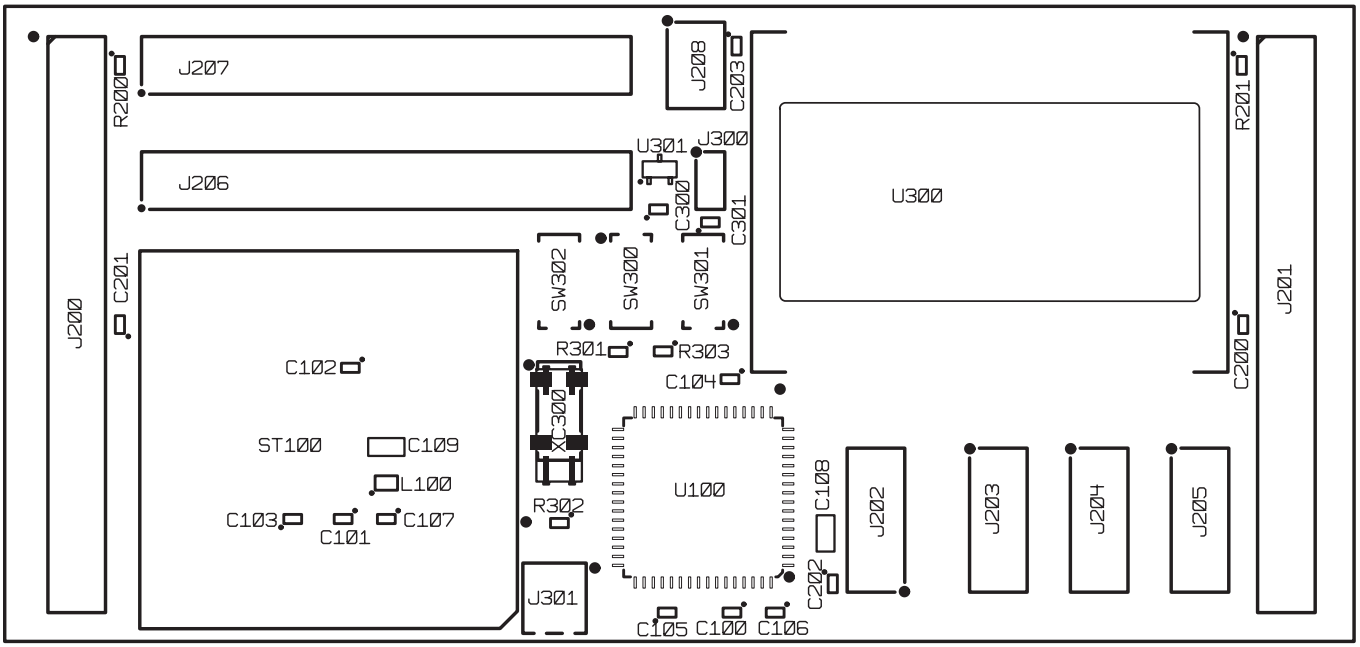


Figure 6-4. Assembly Drawing, 1 of 1



ASSEMBLY DRAWING TOP SIDE
VIEWED FROM TOP SIDE

Atmel Headquarters

Corporate Headquarters
2325 Orchard Parkway
San Jose, CA 95131
TEL 1(408) 441-0311
FAX 1(408) 487-2600

Europe
Atmel Sarl
Route des Arsenaux 41
Case Postale 80
CH-1705 Fribourg
Switzerland
TEL (41) 26-426-5555
FAX (41) 26-426-5500

Asia
Room 1219
Chinachem Golden Plaza
77 Mody Road Tsimhatsui
East Kowloon
Hong Kong
TEL (852) 2721-9778
FAX (852) 2722-1369

Japan
9F, Tonetsu Shinkawa Bldg.
1-24-8 Shinkawa
Chuo-ku, Tokyo 104-0033
Japan
TEL (81) 3-3523-3551
FAX (81) 3-3523-7581

Atmel Operations

Memory
2325 Orchard Parkway
San Jose, CA 95131
TEL 1(408) 441-0311
FAX 1(408) 436-4314

Microcontrollers
2325 Orchard Parkway
San Jose, CA 95131
TEL 1(408) 441-0311
FAX 1(408) 436-4314

La Chantrerie
BP 70602
44306 Nantes Cedex 3, France
TEL (33) 2-40-18-18-18
FAX (33) 2-40-18-19-60

ASIC/ASSP/Smart Cards
Zone Industrielle
13106 Rousset Cedex, France
TEL (33) 4-42-53-60-00
FAX (33) 4-42-53-60-01

1150 East Cheyenne Mtn. Blvd.
Colorado Springs, CO 80906
TEL 1(719) 576-3300
FAX 1(719) 540-1759

Scottish Enterprise Technology Park
Maxwell Building
East Kilbride G75 0QR, Scotland
TEL (44) 1355-803-000
FAX (44) 1355-242-743

RF/Automotive
Theresienstrasse 2
Postfach 3535
74025 Heilbronn, Germany
TEL (49) 71-31-67-0
FAX (49) 71-31-67-2340

1150 East Cheyenne Mtn. Blvd.
Colorado Springs, CO 80906
TEL 1(719) 576-3300
FAX 1(719) 540-1759

Biometrics/Imaging/Hi-Rel MPU/
High Speed Converters/RF Datacom
Avenue de Rochepleine
BP 123
38521 Saint-Egreve Cedex, France
TEL (33) 4-76-58-30-00
FAX (33) 4-76-58-34-80

e-mail
literature@atmel.com

Web Site
http://www.atmel.com

© Atmel Corporation 2002.
Atmel Corporation makes no warranty for the use of its products, other than those expressly contained in the Company's standard warranty which is detailed in Atmel's Terms and Conditions located on the Company's web site. The Company assumes no responsibility for any errors which may appear in this document, reserves the right to change devices or specifications detailed herein at any time without notice, and does not make any commitment to update the information contained herein. No licenses to patents or other intellectual property of Atmel are granted by the Company in connection with the sale of Atmel products, expressly or by implication. Atmel's products are not authorized for use as critical components in life support devices or systems.

ATMEL®, AVR®, and AVR Studio® are the registered trademarks of Atmel Corporation.

Microsoft®, Windows®, and Windows NT® are the registered trademarks of Microsoft Corporation.

Other terms and product names may be the trademarks of others.

Printed on recycled paper.

2528A–AVR–11/02 /0M